

Ambient Wave Propulsion Challenges

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The concept of radiating energy directionally from a spacecraft via plasma waves offers the potential for propellantless propulsion in planetary, and possibly solar, magnetospheres. Plasma wave propulsion takes advantage of an observed astrophysical and terrestrial phenomenon: Alfvén waves. These are waves that propagate in the plasma and magnetic fields around and between planets and stars. The generation of Alfvén waves in ambient magnetic and plasma fields to generate thrust is proposed as a truly propellantless propulsion system which may enable an entirely new matrix of exploration missions.

In order to couple to the ambient plasma and magnetic environment, an Alfvén wave propulsion system requires a properly designed antenna and AC power at the proper frequency to launch Alfvén waves (). The antenna design and frequencies will be determined by the plasma environment and the Alfvén wave dispersion relation. Antenna scales will be on the order of a wavelength, and frequencies will be below the ion cyclotron frequency of the environment. Under these conditions, the concept works by directionally generating Alfvén waves along the ambient magnetic field, resulting in radiation pressure that produces thrust on the antenna. The generated thrust is proportional to the perturbed magnetic field strength in the waves, δB^2 , and the area of the antenna.

In order to launch linear Alfvén waves, the perturbation must be less than the ambient field, which imparts a limit on the thrust density of this concept, unless non-linear effects are to be incorporated and considered. Two aspects of this concept have been examined:

- the feasibility of wave propagation in relevant environments such as the Jovian or terrestrial magnetospheres, and
- the coupling of some representative antenna designs to these waves.

The wave fields, thrust, and power requirements have been calculated for some representative antenna designs, and further analysis and optimization work are identified.

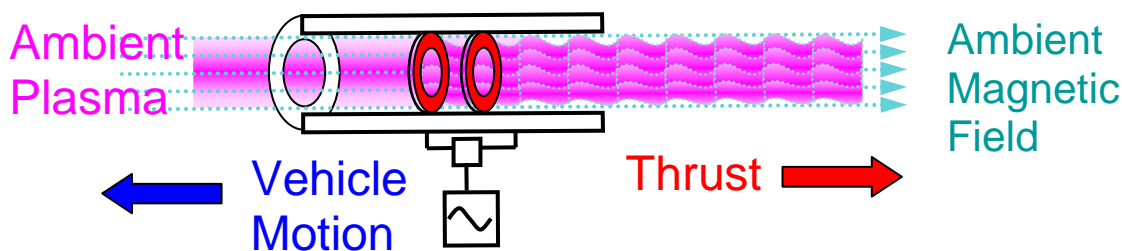


Figure 1. Plasma wave propulsion concept.